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JSC Training Guide for SSP Customers

Space Flight Training & Facility Operations Payload/Comm Department

Revision A
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JSC Training Guide for SSP Customers

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Foreword

The content of this document was provided by the Payload Training Group, Space Flight Training & Facility Operations (SFT&FO) Department, Space Flight Training Division, Mission Operations Directorate (MOD), Lyndon B. Johnson Space Center (JSC), National Aeronautics and Space Administration (NASA). Technical documentation support was provided by Hernandez Engineering, Inc., Space Flight Operations Contract (HEI–SFOC). Any questions concerning this training manual or any recommendations should be directed to the training manual book manager, Robert Graubard, at DT37, (713) 244–7415.

This material is for training purposes only and should not be used as a source of operational data. All numerical data, displays, and checklist references are intended only as examples. To determine any prerequisites before using this document, consult the applicable Certification Plan. For shuttle manuals, consult the Instructor Certification Guide (Blue Book) or the Crew Training Catalog. For Space Station manuals, consult the appropriate Space Station Certification Training Guide or Training Administration Management System (TAMS). The applicable training package should be studied before attending any classroom session or lesson for which this is a prerequisite.

A Training Materials Evaluation is included at the end of this document. Inputs on this sheet will be used to evaluate the lesson material. You do not need to sign the sheet.

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Section 1
Introduction

This document is designed to familiarize customers with flight training at the Lyndon B. Johnson Space Center (JSC). Flight training is the responsibility of the Mission Operations Directorate (MOD). See Figure 1–1 for an organizational breakdown of directorates and offices at JSC. This document includes an overview of the Training Division's responsibilities for a Space Shuttle Program (SSP) flight, its responsibilities to the customer who is sending a payload on that flight, and the responsibilities of the customer to support the division's training activities.

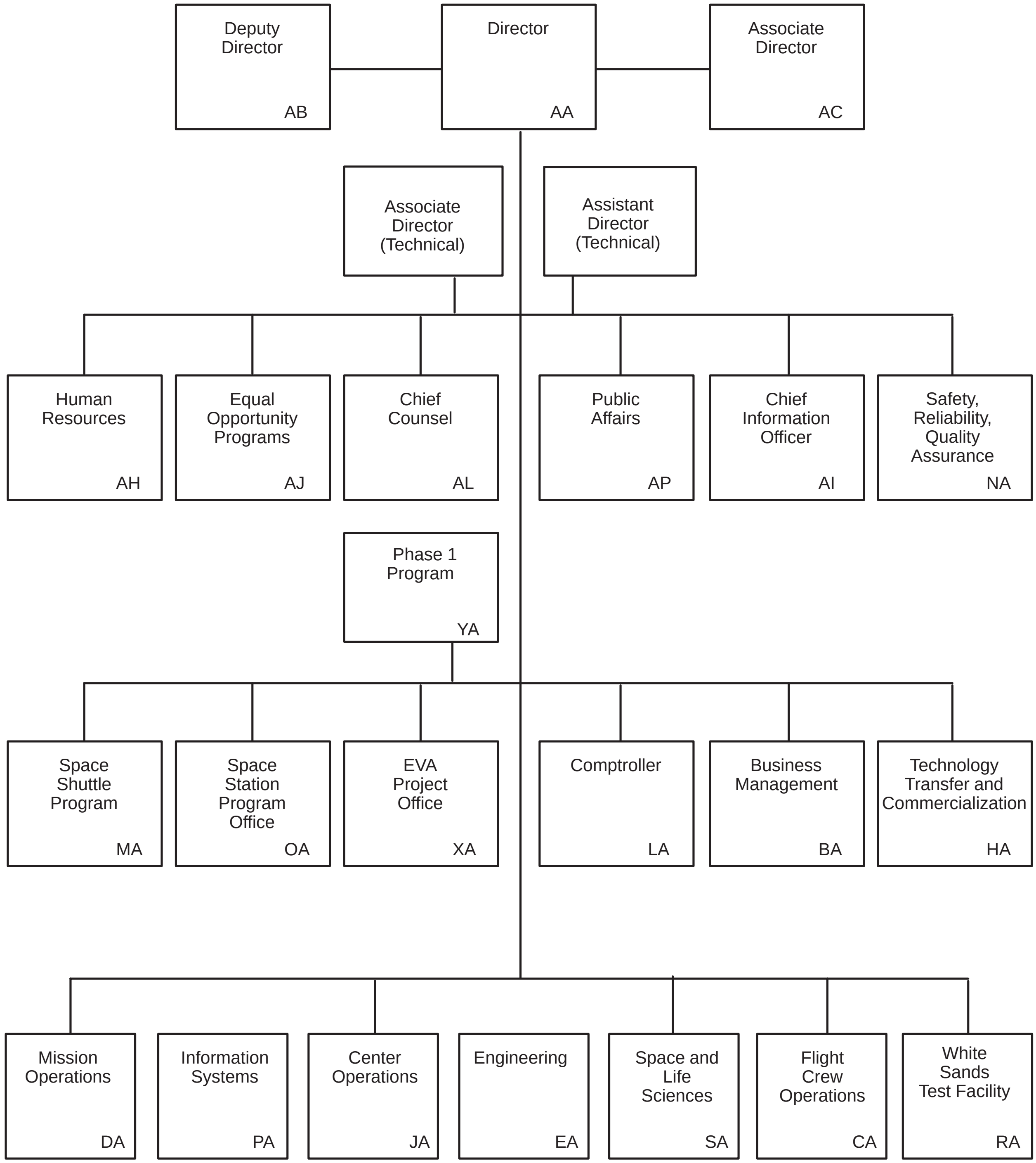

Figure 1–1. Johnson Space Center organization (directorate level)

Training–Related Components of Mission Operations Directorate

Figure 1–2 illustrates the following components of MOD involved in JSC training activities:

- Flight Director Office (DA8)
  - Directs flight activities from the Mission Control Center (MCC) at JSC
  - Participates in integrated and Joint Integrated Simulations (JISs)
  - Chairs Flight Operations Integration Group (FOIG) meetings that determine the number of integrated/joint integrated simulations to be conducted for a given mission
- Systems Division (DF)
  - Provides systems flight controllers for all JSC missions
  - Provides flight systems handbooks and operating procedures to support training, simulations, and real–time flight operations
  - Develops and validates procedures and training for crew systems, intravehicular activity, and extravehicular activity
- Operations Division (DO)
  - Provides payload officers and flight activity officers
  - Develops flight rules
  - Develops integrated procedures for the majority of the Flight Data File (FDF)
  - Plans and develops timelines for preflight and real–time crew activity
  - Develops operational plans and concepts
  - Provides crew activity flight controllers for all JSC missions
- Flight Design and Dynamics Division (DM)
  - Develops flight trajectories
  - Develops launch and entry procedures and carry–on computer programs
  - Provides flight dynamics flight controllers, including onboard and ground navigation, for all JSC missions

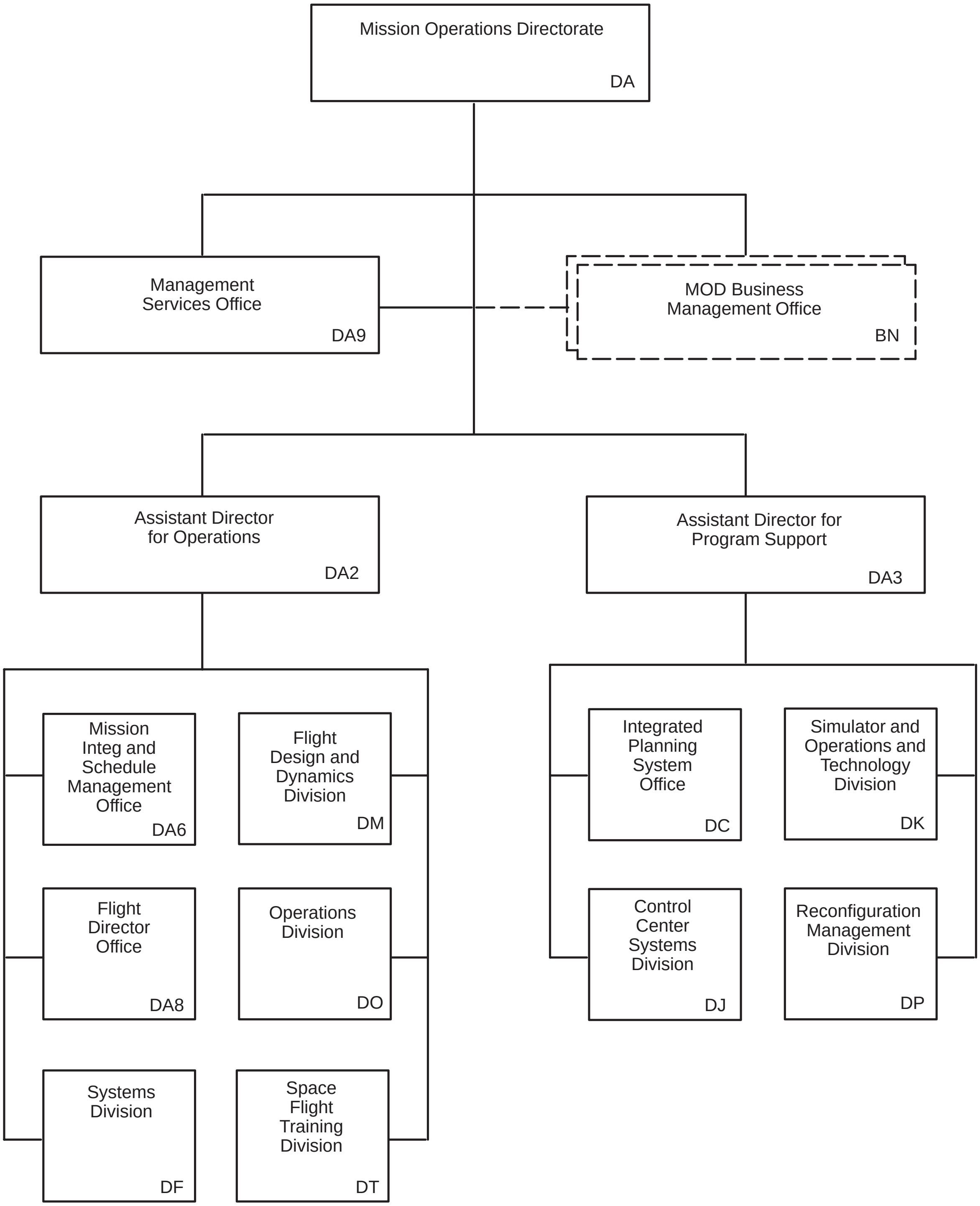

Figure 1–2. Elements of the MOD involved in training activities at JSC

- Space Flight Training & Facility Operations (DT)

  Figure 1–3 depicts the internal organization of the Space Flight Training & Facility Operations (SFT&FO) Department. A list of the functions of the department follows:

  – Manages the development and conduct of all flightcrew and flight controller training programs

  – Plans, schedules, and coordinates all training

  – Establishes overall requirements and develops all elements of training in classrooms and other JSC training facilities

  – Integrates training requirements from the Payload Integration Plan (PIP) Training Annex, Cargo Integration Review (CIR), etc.

  – Develops training curricula and provides training instructors

  – Defines simulator and trainer requirements and identifies the need for other facilities and equipment

  – Develops and operates various part–task training facilities and equipment

  – Develops payload software models for the Shuttle Mission Simulator (SMS) activities

  – Implements payload software models in the SMS for crew and ground training

  – Provides facilities and support for all SMS–related activities

  – Provides facilities and support for all MCC–related activities

  – Implements payload Cathode–Ray Tube (CRT) display requirements

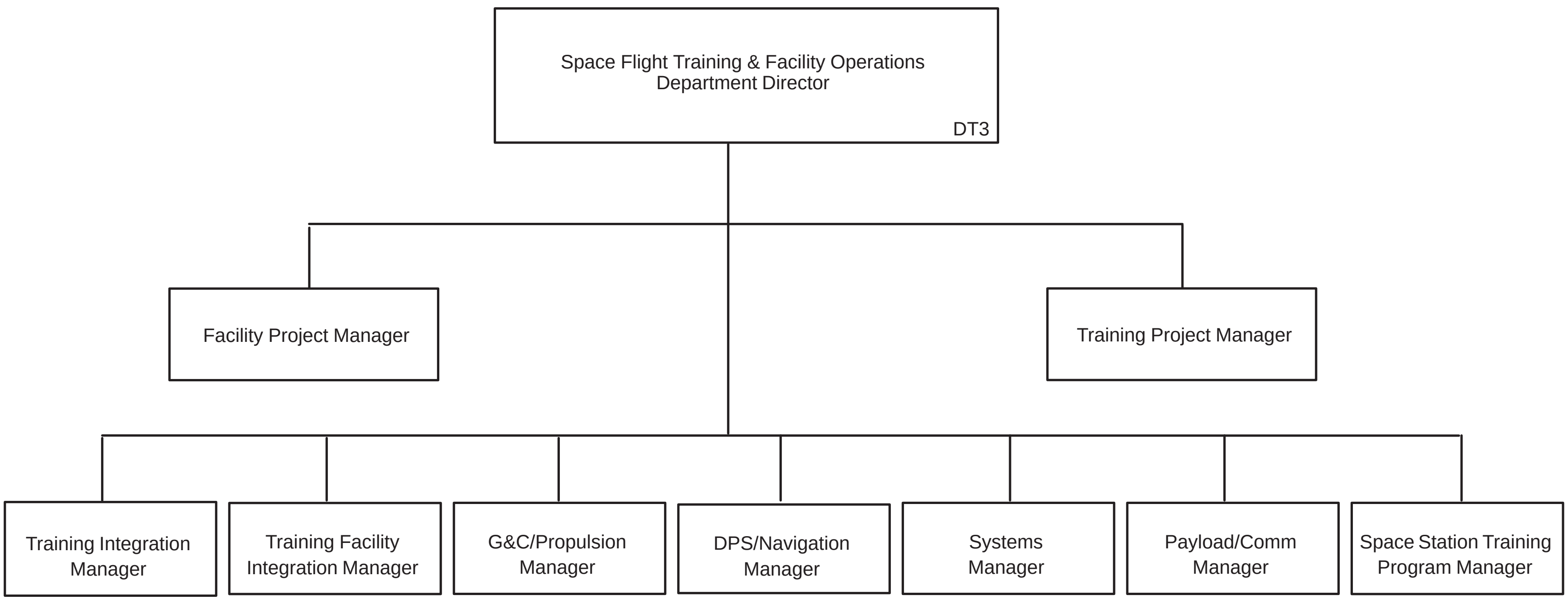

Figure 1–3. Internal organization of Training Division

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Section 2
Joint Training Requirements

Payload Integration Plan

The flight of a payload aboard the space shuttle begins with a contract between the customer and the SSP; this contract is a PIP. Figure 2–1, joint training requirements timeline, graphically depicts the chronological order of events that occur between the customer and JSC. The timeline shows some of the significant events preceding the launch of a shuttle flight. Activities marked with an asterisk involve little or no customer interaction, but are included in the timeline to provide a clearer picture of preflight preparations. The emphasis is on training, simulations, and associated milestones related to the SSP. The following information is generally included in a PIP:

- NASA responsibilities.
- Customer responsibilities.
- Joint responsibilities.
- Designation of those persons or groups who will manage the payload project. Managers from both NASA and the customer are included.
- Payload description.
- Activities and interfaces necessary to integrate the payload into the shuttle.
- On–orbit activities and interfaces.
- List of nonstandard services and pricing data.
- Schedule requirements.

Section 8.3 of the PIP is entitled “Training.” It contains information concerning the training of the crew and flight controllers. Training for each payload requires different simulation techniques, equipment, parameters, visuals, and other training aids.

Responsibilities

The MOD has the overall responsibility of training the flightcrew and flight controllers in all aspects of payloads systems and payload operations for the payload. The customer is responsible for training the flightcrew and flight controllers in all aspects of the experiments associated with the payload.

MOD and the payload customer will jointly identify the training objectives, including critical training objectives that are required to be successfully completed by the flightcrew and support personnel. Critical payload training objectives are those that are required for mission safety and payload mission success.

MOD will develop a flightcrew training flow that provides the appropriate number of sessions for the flightcrew.

The customer is responsible for providing the lessons that are necessary to sufficiently train the flightcrew to support the operational roles and responsibilities directly associated with operating the payload experiment and/or experiment software that is provided by the customer.

The customer will provide details for payload systems operations as required to satisfy the training objectives for the flightcrew and flight controllers.

They payload customer is responsible for providing payload–specific training for the payload support personnel residing in the JSC POCC or the payload remote POCC. The payload customer is also responsible for conducting intercenter exercises that do not involve JSC participation.

The customer is required to provide schematics/diagrams to support simulator model development (as applicable) and crew and flight controller training. Specific diagram/schematic requirements and delivery dates will be defined in the PIP and/or Annex 1.

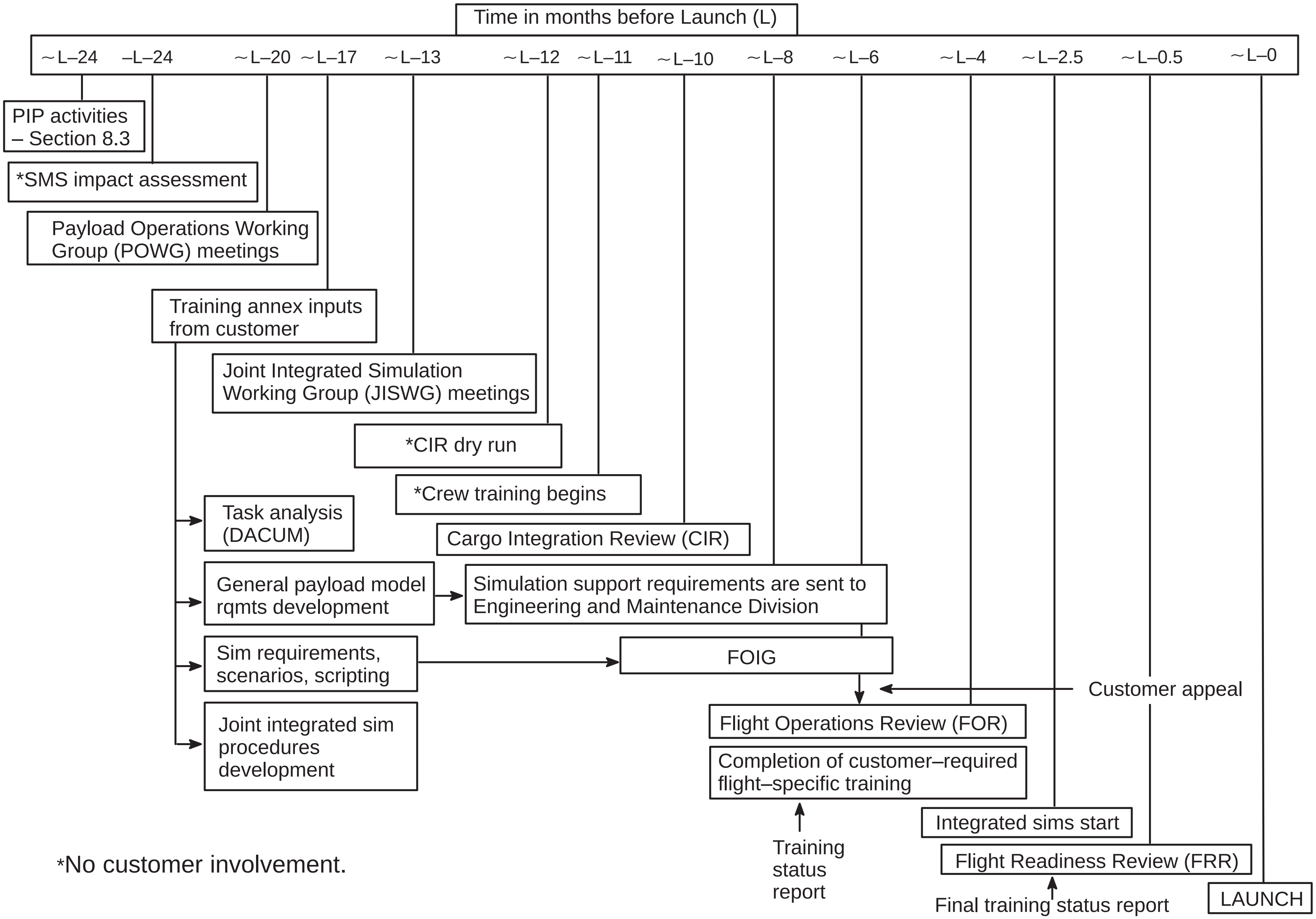

Figure 2–1. Joint training requirements timeline

Payload Integration Plan Annexes

As the flight preparations proceed, more specific requirements and agreements are confirmed by NASA and the customer. These are documented in books known as PIP annexes. Training requirements and data are based on information contained in the following annexes:

Annex	Title
1	Payload Data Package
2	Flight Planning
3	Flight Operations Support
4	Command and Data
5	Payload Operations Control Center
6	Crew Compartment
7	Training
11	EVA

Training Annex

Annex 7, the Training annex, is developed by the Training Division and baselines the training for payload–related activities. It contains the following information:

- Customer–provided training to SSP personnel
- SSP–provided training to customer personnel
- JIS requirements
- Model requirements for SMS operation (e.g., command, telemetry, malfunctions, visuals)
- Milestones to assist the SSP organization in preparing master training schedules

A training annex may not be required depending upon the complexity of modeling the payload and the payload interfaces with the orbiter. If a training annex is not required, then section 8.3 of the PIP will state the formal program level agreements between the customer and the SSP regarding payload training. Further refinement and definition of the agreements and requirements stated in the PIP will be developed through the JISWG and/or other informal mediums as mutually agreed by the SSP and the customer.

Shuttle Mission Simulator Impact Assessment

After the Training section of the PIP (Section 8.3) is completed, a payload training supervisor (PTS) from JSC examines the training necessary for the flight based on training objective inputs from the customer. The PTS develops a set of training requirements and presents them to the Simulator and Operations and Technology Division. The Simulator and Operations and Technology Division then assesses the impact of the training requirements on the SMS and determines their feasibility in terms of visuals, bit streams, and hardware modifications. If training requirements exceed standard service agreements, then the fidelity requirements and costs are negotiated with the customer.

Payload Operations Working Groups

Payload Operations Working Groups (POWGs) are organized and called into action to develop mission plans and flight rules. Organizing a POWG is the responsibility of the Operations Division.

POWGs are involved in developing annex 3, the Flight Operations Support Annex (FOSA). The groups also meet to work out payload–related concerns which arise at any point in the crew Flight Plan.

Cargo Integration Review

The CIR is a meeting which surveys the status of all preparations for the upcoming flight. It is usually about 4 days long – 3 days of working group meetings, concluding with a large meeting called a CIR board meeting.

The participants include the following:

- Customer representatives for each payload
- Crewmembers
- Representatives from the MOD – training manager from the Training Division
- Representatives from other JSC directorates
- John F. Kennedy Space Center (KSC) representatives
- Representatives from any other NASA centers involved
- Contractors who are involved with the flight

The following topics are addressed:

- Flight trajectory
- Timelines
- Customer–provided training
- SSP–provided training
- Engineering compatibility of payloads
- Hardware/software interfaces

The CIR is also the optimum time to ensure that all the PIP annexes are signed off if they have not been baselined previously.

Task Analysis

Design A Curriculum (DACUM) is a streamlined method of doing task analysis. It consists of two or three consecutive half–day meetings with key participants for a given payload. This process aids in the development of training objectives and model requirements. The DACUM requires the key participants to gather together to identify job performance requirements and training requirements. The key participants include the following people:

- Moderator
- Project engineer
- Lead payload officer
- Crew representative
- Customer representative
- Instructor representative
- Curriculum developer
- PTS

Joint Integrated Simulation Working Groups

The Joint Integrated Simulation Working Group (JISWG) is the group that provides nominal as well as non–nominal scenarios to be trained in an integrated environment. The JISWG participants include payload customer representatives, the PTS, and the Simulation Supervisor (Sim Sup). This group meets periodically beginning at launch (L) – 18 months. The objectives of each JISWG vary depending on the nature of the payload and the JSC training group associated with the payload. A JISWG agenda is used to complete the effort in a timely manner. A JISWG agenda guideline is provided in appendix B. A list of some of the objectives follows:

- Simulation philosophy and the customer’s simulation role and responsibility
- JIS coordination (i.e., how many and what types)
- Joint Integrated Simulation Operations Handbook (JOH) development
- Establishment of training objectives, simulation procedures, unique simulation interfaces, malfunctions, and scripts for simulation
- Coordination of remote payload facility interfaces to the SMS and MCC

The JISWG produces the scenarios and scripts for the simulations. Scripts create interaction between JSC flight controllers, the flightcrew, and the Payload Operations Control Center (POCC) personnel. These scripts are developed by analyzing crew and flight controller tasks in the DACUM, by which a prioritized list of training objectives is generated. Training objectives are used in the JISWG to ensure that all training representatives understand the areas which need to be stressed. These training objectives are then used to prioritize, guide, and track the accomplishments of training. Scenarios create situations for procedures, flight rules, and timelines in order to clarify responsibilities.

Flight Operations Integration Group

At L – 6 months, the integrated simulations for the flight are baselined at an FOIG meeting. The FOIG is a group within the MOD, chaired by the head of the Flight Director Office. The group includes the following people:

- Head of the Flight Director Office
- Deputy chief of the Systems Division
- Deputy chief of the Training Division
- A simulation scheduling officer
- Payload officers
- Lead Sim Sup
- PTS

The FOIG meeting is the arena for any customer concerns regarding the number of simulations, scheduling, or content, or any other aspects of the JISs may be addressed. The customer may attend the meeting to address concerns directly to the group, or concerns may be addressed to the FOIG via any of the following FOIG members:

- Payload officer
- Lead Sim Sup
- PTS

Flight Operations Review

The Flight Operations Review (FOR) is an opportunity for the customer to review all payload–related FDF and associated mission documentation and to write Discrepancy Reports (DRs) against these documents, if required. The status of flight training is one of the topics at the FOR. Any training problems or concerns are presented at this review.

The FOR is typically a 4–day meeting scheduled at approximately L – 3 months.

Flight Readiness Review

The Flight Readiness Review (FRR) examines every facet of flight preparation to determine whether or not the flight will be ready for launch at the scheduled date.

Participants at the FRR include upper–level managers from every organization involved with the flight. This review is usually conducted 2 weeks prior to launch via telecon.

Section 3
JSC–Provided Training

The SSP provides certain standard and optional training to support a payload. Nonstandard services are those provided at additional costs to the customer.

Mission Control Center Training for Customer Representatives

Generic MCC – Houston (MCC–H) console training is provided for payload customer representatives who will be resident in the MCC at Houston during the mission. This training involves workbooks and up to 2 hours of hands–on training for each representative. Additional representatives may also be provided training; however, their training must be negotiated between the SSP and the customer.

Payload Specialist Training

If the customer plans to supply a PS(s) for the flight, add the following statement: The MOD will provide training for the payload prime and backup PSs as a nonstandard service to the customer. MOD will provide full mission preparation training to the primary PS and will accommodate one backup PS to the fullest extent possible at the discretion of the mission commander. This service will include training for orbiter habitability, crew systems (communications, lighting, and FDF familiarization), operations, and safety. The details of this training will be found in Annex 7; the Payload Specialist Flight Preparation Plan, JSC–23194; and Payload Specialist Operations and Integration Plan, JSC–19936.

Payload Operations Control Center Participation in Simulations

If the customer requires the use of a remote or MCC POCC, then the customer is required to exercise the Joint Operations Interface Procedures (JOIPs) and any malfunction or contingency operations.

The customer supports these simulations by providing POCC operators and management support personnel in the MCC.

Visual Model for Shuttle Mission Simulator

If the payload requirement dictates a need for an SMS visual model, then the SSP will modify the SMS visual system to include a model of the payload. This model is developed from the drawings provided by the customer in the Payload Data Package, annex no. 1.

If a complex visual model (one requiring more than 400 hours of effort) is needed, the SSP will provide it as a nonstandard service.

Standard Switch Panels, Control and Display Panels, General Purpose Computer Displays

If the payload requires use of the standard switch panel or if it requires a unique Control and Display (C&D) panel or General Purpose Computer (GPC) displays, the SSP will provide a functional math model of the payload for use in the SMS. The customer may provide a functional math model or the required control panel as a nonstandard service. A nonstandard charge would also be required to integrate a panel provided by the customer into the SMS.

The customer provides a listing of commands, telemetry, and payload malfunctions to support the development of the math model.

Payload Deployment and Retrieval Training

If the payload requires the use of the Remote Manipulator System (RMS) for deployment, JSC will provide RMS training to the crew to perform this deployment. This is a standard service to the customer. However, any other RMS activity, rendezvous/prox ops procedure, or retrieval is a nonstandard service. Balloon models that are required for the Manipulator Development Facility (MDF) may be an optional service.

Extravehicular Activities Training

If the customer requires the SSP to accomplish a planned Extravehicular Activity (EVA) or to be prepared to accomplish a payload contingency EVA, then JSC will provide EVA training to the crew as a nonstandard service. The primary training facility for EVA training is the Neutral Buoyancy Laboratory (NBL).

Travel

For customer–required training, the SSP will provide, as a standard service, the travel costs associated with sending the flightcrew and support personnel to the customer training facility for up to two trips of 2 days per trip. Travel costs associated with customer–required training that exceed this allocation will be a nonstandard service cost to the customer.

Unique Training

If the SSP determines that a Payload Prelaunch Simulation (PPS) is required, add the following: The SSP requires that the customer participate in a PPS to exercise the launch commitment decision process established for the mission. The PPS will be scheduled in conjunction with the mission Terminal Countdown Demonstration Test (TCDT) that occurs after the orbiter arrives at the launch pad. Planning for the PPS will be developed during one of the JISWG meetings. The PPS procedures will be incorporated into the JIS procedures document.

Payload Data Stream

If a payload data stream to a remote POCC is required by the customer, it will be developed, built, and checked out in the SMS as a nonstandard service. The ability of the SSP to provide a simulated Payload Data Interleaver (PDI) data stream is dependent upon the PDI data being compatible with the SMS hardware architecture, software capabilities, and SSP resource availability.

Section 4
Customer–Provided Services

Briefing to Crew and Flight Operations Support Personnel

The customer provides this briefing to familiarize the crew and the FOSP with the payload. A guideline for the customer familiarization briefing is provided in Appendix A. A more detailed set of guidelines may be found in JSC–25716, Payload Familiarization Briefing Guidelines. The customer is required to provide the PTS with a preliminary outline of the briefing prior to the scheduled date for the session. The PTS will negotiate with the customer the time allotted for the briefing. The time allotted for the briefing will depend upon the complexity of the payload.

Training Representative to Cochair Joint Integrated Simulation Working Groups

A representative of the customer cochairs the JISWGs. During the JISWGs, this customer representative plays a key role in determining the objectives for the simulations, coordinating the involvement of the customer's POCC personnel in the simulations, and scripting malfunctions to train the crew and FOSP to handle the payload in normal and abnormal conditions.

Review of the Flight–Specific Joint Integrated Simulation Operations Handbook

The JOH is a document which defines external interface and simulation procedures among the control centers participating in joint simulations. This document may be required, depending on the complexity of the payload.

Documentation

The customer must ensure through the joint documents (e.g., PIP, PIP annexes, and JOH) that payload requirements are well defined and correct to support the flight implementation by the SSP organization.

Payload Training to Flightcrew and to Other JSC Personnel

In addition to the briefing described at the beginning of this section, it may be necessary for the customer to provide a certain amount of training to the flightcrew and to other JSC personnel who deal with the payload. This training will be defined and agreed upon in the Training Annex, annex 7, to the PIP.

Scheduling Information

Scheduling of integrated simulations is coordinated between the customer's POCC schedulers and JSC schedulers. The customer's point of contact for scheduling is the Payload Officer in the JSC Payload and Operations Support Branch. As a means of providing the current scheduling information to the simulation planners and participants, frequently updated telephone recording is provided at 483–1076.

All payload procedures and training hardware/sofrtware shall be ready to begin flightcrew training no later than L – 6 months.

All customer–provided training, or customer–required training, must be completed no later than L – 13 weeks.

Development of Shuttle Mission Simulator Models

It is necessary for the payload customer to provide certain data to the Training Division before the division can determine the fidelity which will be required to simulate payload operations in the SMS. These data are mainly provided via the PIP or training annex (if published), POWG, and JISWG and are used as a database for the design of a General Payload Model (GPM) for the SMS, if necessary. The following is a list of required data:

- Command and data interfaces
- Status data as a function of command or switch input
- List of payload telemetry required for simulations
- List of types of malfunctions which the payload developer feels should be exercised during simulations
- List of commands which the payload developer desires to exercise during simulations
- Systems schematic data defining how the payload operates

The customer designates a point–of–contact who is an expert about payload design and who can answer detailed questions about the operation of the payload. This representative also supports the scripting for the JISs.

Payload General Support Computer

If a PGSC is utilized for payload commanding/telemetry, the payload customer will provide a PGSC compatible emulator. The emulator will allow the flightcrew to exercise payload operating procedures that are performed using the PGSC. Depending upon crew payload training objectives, the customer may provide training software that can be integrated with the PGSC training load to allow the crew to accomplish the same training objectives as those of the payload emulator.

Section 5
Simulations

Objectives

Simulations (also known as sims) are an important part of the training provided by JSC. During sims, the crew and the flight controllers exercise procedures required by normal conditions, as well as the techniques and procedures used during abnormal situations.

Development work is also facilitated by sims. Sims offer opportunities to verify flight software. They also provide scenarios for development of contingency procedures and for verification of flight rules.

The types of sims include voice communications (voice comm) protocol, standalone, integrated, and joint integrated. Each of these sims is described in this section. Figure 5–1 illustrates the different types of sims that are conducted at JSC.

Voice Comm Protocol Simulations

The primary purpose of a voice comm protocol sim is to expose new customers to their roles in console support in sim exercises and in flight operations.

Voice comm protocol sims exercise personnel in the use of voice loops without using the simulators. Customer representatives and flight controllers use the Digital Voice Interfacing System (DVIS) to talk through a timeline. Malfunctions are inserted so that the players may practice comm procedures required by those malfunctions. Before participating in this sim, it is recommended that the customer review the JOIP and the JOH documents.

A flight may require a voice comm protocol sim if it is a customer's first exposure to the SSP procedures or if the customer's interfaces with the MCC are very complex. This type of sim should occur no later than 1 week prior to the first JIS.

Standalone Simulations

A standalone sim, also called a nonintegrated sim, is one in which only the flightcrew and a team of SMS instructors are involved. The SMS is used, and all participants are located within the SMS building at JSC. A crew's first standalone sim involving payloads for its specific flight usually begins about 11 weeks before launch.

Integrated Simulations

An integrated sim involves flight controllers, ground controllers, and instructors in the MCC, in addition to the flightcrew and the team of instructors located in the SMS building. The instructors in the MCC are the people who execute the scripts for the sim under the direction of the Sim Sup. These sims require the use of the Network Simulation System (NSS) in addition to the Motion Base (MB) or the Fixed Base (FB) simulator. A crew's first integrated sim usually occurs about 9 to 10 weeks before launch.

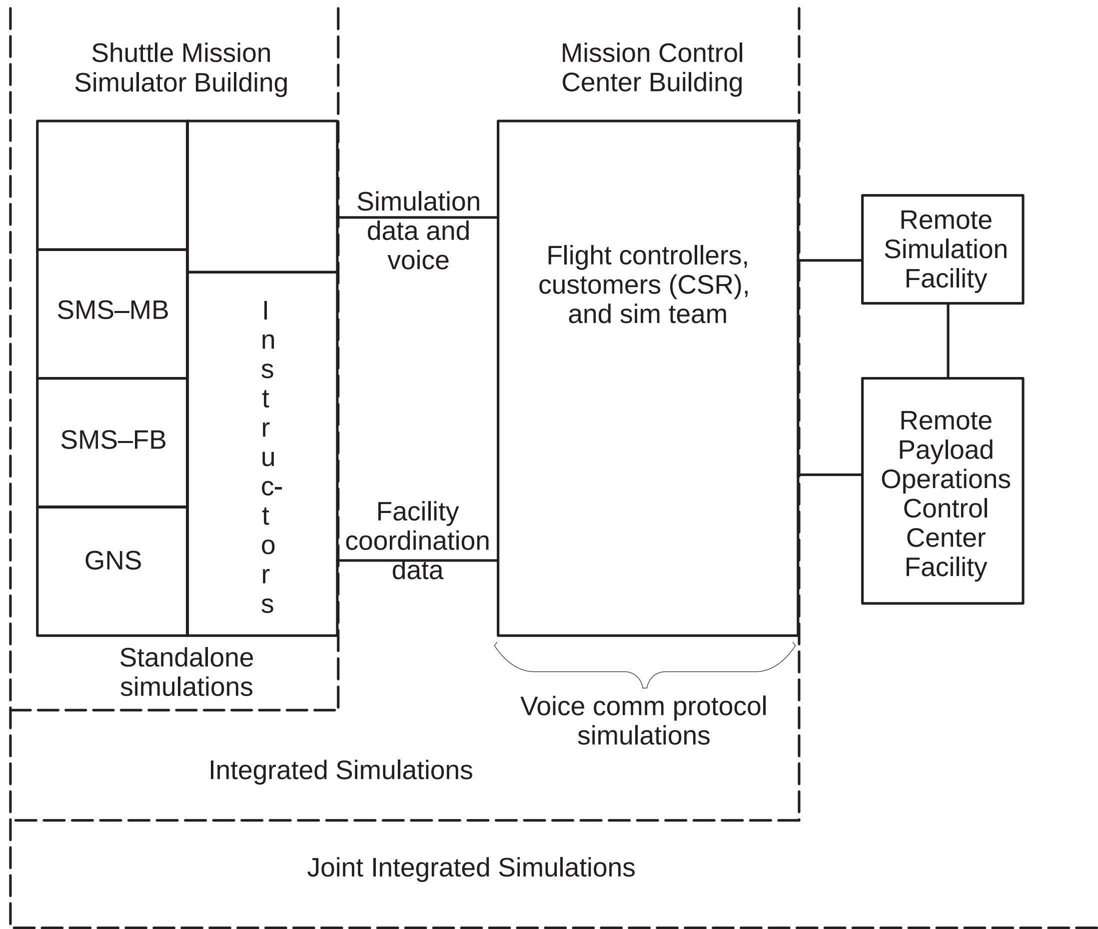

Figure 5–1. Interaction between some of the individuals involved in different types of sims

Joint Integrated Simulations

When the customer staffs a POCC and participates in an integrated simulation, the training exercise is called a JIS. Depending on the demands of the payload, this POCC may be a room in the MCC (for example, the Customer Support Room (CSR)) or it may consist of one or more large centers at a remote location or locations. In addition, the same participants who are involved in an integrated sim are also involved in the JIS: the flight controllers and Simulation Control Area (SCA) instructors in the MCC and the SMS instructors and flightcrew in the SMS building.

A JIS is a large–scale dress rehearsal of a portion of the actual flight. It provides training in the interaction between the crew and MCC personnel, in responses to stressful situations, and in malfunctions resulting in customer interaction and is one of the testing grounds for payload data and command flow verification.

The JISs begin at about the same point in the timeline as the integrated sims. The customer negotiates with JSC to determine the number of JISs required to ensure mission readiness. The number and type of malfunctions, the start time (Mission Elapsed Time (MET)), and the initial conditions are also jointly determined by the customer and JSC.

Table 5–1 lists the participants and facilities involved in the various types of JSC–provided sims. Figures 5–1 and 5–2 show the interaction between the individuals involved in a JIS.

Table 5–1. Simulation participants and facilities

Sims / Facilities/ participants	Voice–comm protocol	Crew standalone	Integrated	Joint integrated
Voice loops	X	X	X	X
SMS		X	X	X
NSS			X	X
Flight Control Room (FCR) (in MCC)	X without the MOC*		X	X
Simulation control area in MCC	X		X	X
Remote and local POCC	X			X
Flightcrew		X	X	X
SMS instructors		X	X	X
SCA instructors	X		X	X
Flight and ground controllers	X		X	X
Customer	X			X

*MOC is the mission operations computer.

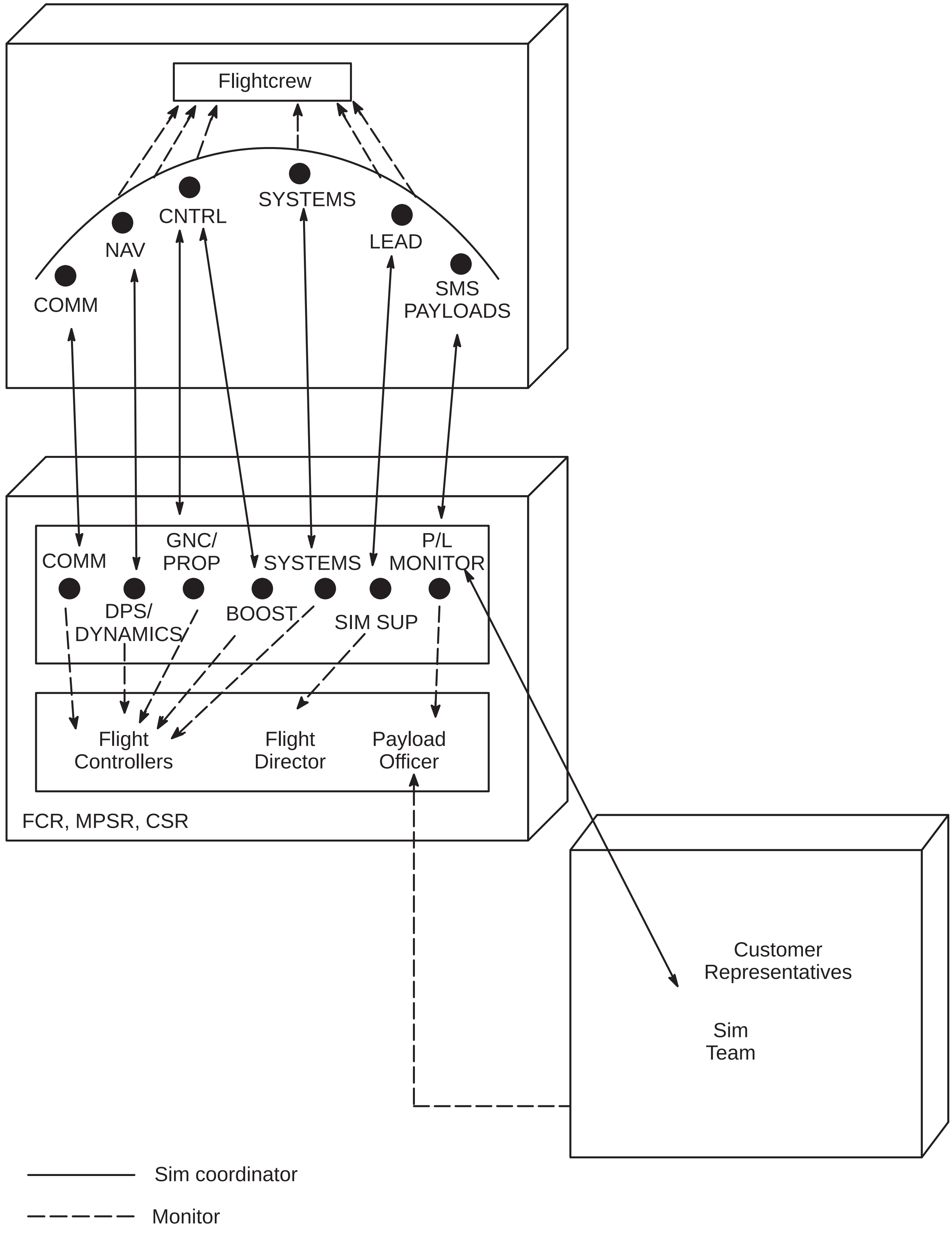

Figure 5–2. Facility coordination during a JIS

General Payload Model

The GPM is part of the software program in the SMS. The payload model provides the necessary software to drive orbiter displays, to output telemetry in the proper format through the correct data interfaces, and to respond to commands from the orbiter or the ground. In order to accommodate simulations involving the satellite/payload, a separate model for each payload must be constructed. This model allows the simulated payload to interface with the orbiter models. The models are built only to the fidelity required to meet the training objectives.

For the construction of the GPM, an application must be built and installed on the NASA Training Division (DT) personal computer (PC) network. This application allows the entry of GPM requirements used to support crew training for shuttle missions. The interface allows input of the Boolean logic in a graphical format and definition of the instructor pages using screen layout method. The information input into the application is collected and stored in a database. A program retrieves the information from the database and builds a specification as described in the GPM requirements document. This specification is processed by the assembly language (Application Specific Language (ASL)) GPM residing on the AUTO–DOC platform and generates software products as specified in the GPM Requirements Document. The final product is a FORTRAN program that enables the SMS computers to drive the orbiter displays, to format telemetry, and to cause the payload model to react to commands or malfunctions inserted by the sim team.

The JSC Training Division is responsible for developing the logic flow diagrams at approximately L – 12 months. The customer may provide inputs to the Training Division in the form of functional payload system schematics which adequately explain the payload logic design and/or logic flow diagrams. The PTS takes these inputs, as well as inputs from the various PIP annexes, and develops a final logic flow design which includes the SMS interface requirements, malfunction capability, and instructor inputs. In order for the model to be accurate, the PTS must understand in detail how the simulated data outputs are affected by command and switch inputs. Therefore, the customer must provide support to the Training Division through a point–of–contact who is knowledgeable about payload design and who can answer the detailed questions involved. A working relationship that ensures configuration control is agreed to during the PIP process.

Section 6
Payload–Related Training Facilities at JSC

Payload Trainer

The Payload Trainer is a computer–based training tool situated in one room on the second floor of building 4 south. Computer drawn images of payload control panels are displayed on CRTs. The student “performs an action” by using a computer mouse to click on whatever function he or she wishes to perform. The software then displays the appropriate response on the CRT in the form of a talkback reaction or simulated computer display readout. The primary objective of the Payload Trainer is to provide a simple, cost–effective learning tool for the practice of flight–specific payload operational procedures. Figure 6–1 shows two of the payload trainer workstations.

The Payload Trainer is also used to verify payload simulation software that is installed into the SMS software mission load, which is usually the software developed to construct a GPM as detailed in section 5. The SMS is used for advanced mission training that occurs later in the flightcrew training flow.

Figure 6–1. Payload trainer

Single System Trainer

The Single System Trainer (SST) is a small training complex located on the second floor of building 4 south. It consists of three separate and independently operated mockups of the space shuttle crew compartment flight deck and aft flight deck. Replicas of most orbiter control panels and a few special payload control panels are physically arranged within each station to be similar to the real vehicle but also to allow convenient access by the students and instructors. Switches, dials, and meters are low–fidelity copies of the actual hardware, which greatly reduces the cost of the facility since flight hardware and even flightlike hardware are very expensive. A computer system controls the crew CRT displays and talkbacks, depending upon the switch actions or data inputs of the student. The software has been programmed appropriately to re–create the proper real vehicle response to a student's input commands.

The objective of the SST is to provide individual, one–on–one, accurate procedural and operational training on individual orbiter and/or payload subsystems for flightcrews, flight control, and instructor personnel. A student can practice the procedures for only one particular orbiter or payload subsystem at a time and not have to be concerned with the effects other systems have on the particular subsystem on which the student is training.

Software control of the particular system can be altered by the instructor during the training session to induce anomalies and malfunctions that allow the student to demonstrate his or her skill in anomaly recognition and resolution. Figure 6–2 shows the aft flight deck and the flight deck of one of the three SSTs. A small portion of the instructor station can be seen at the lower left corner of the photo.

Figure 6–2. Single system trainer

Shuttle Mission Simulator

The SMS is a large training facility located in the Senator Jake Garn Training Facility, buildings 5 and 35, which consists of three separate and independently controlled high–fidelity mockups of the space shuttle crew compartment flight deck and aft flight deck and a mockup of the Spacelab module. Higher fidelity replicas of all orbiter control panels and most payload control panels are physically arranged within each station in a manner very close to the real vehicle. Switches, dials, and meters are higher fidelity copies of the actual hardware; in fact, many units are identical operational replicas of their respective flight counterparts.

As with the SST, a computer system controls the crew CRT displays and talkbacks, dependent not only upon the switch actions or data inputs of the students but upon the external environment, such as vehicle orbit position, vehicle attitude, and vehicle velocity plus any commands from the MCC. The SMS software has been programmed to a higher degree of fidelity than the SST in order to more accurately re–create the proper real–vehicle response to almost any situation. Software–generated displays of visual scenes as they would be seen out the orbiter forward, overhead, and aft windows are displayed for the flightcrew to view. These scenes include launch tower, launch pad, runways, and payload bay views plus Earth, Moon, and Sun.

The objective of the SMS is to provide highly accurate procedural and operational training on orbiter and payload systems and subsystems for flightcrews, flight control, and instructor personnel in an integrated high–fidelity orbiter crew compartment environment. Students, who consist of an entire flightcrew or a subset thereof, can practice the procedures and activities for all orbiter and payload systems and subsystems in a manner that simulates what they expect or might experience during any of the shuttle flight phases, from prelift–off through ascent and orbit to landing and wheel stop. The integrated capabilities of the SMS require the students to consider all orbiter or payload systems plus the vehicle environment and mission timeline when performing shuttle or payload procedures.

The SMS can be integrated with the MCC, providing more realistic mission training. The SMS generates downlisted data and a flightlike orbiter data stream, which then goes to the SMS NSS.

The NSS simulates the worldwide network of tracking stations, satellite transponders, and the Tracking and Data Relay Satellite System (TDRSS) in such a way that both the MCC and orbiter must take into account the vehicle orbit and attitude (with respect to antenna patterns) and the ground stations or satellite tranponders that are available for voice and data communications and their respective communication characteristics.

There are four facilities within the SMS: two house a complete mockup of the flight deck, aft flight deck, and middeck; one houses only the flight deck; and one houses the Spacelab simulator.

The SMS Motion Base (SMS–MB) (Figure 6–3) is the complex that houses only a mockup of the flight deck. The objective of the SMS–MB is to provide accurate and realistic orbiter systems training for the ascent and landing phases of shuttle missions. The platform upon which the flight deck is mounted has six degrees of freedom and thus can be moved by a sophisticated array of hydraulic systems to almost any position except upside down. The sensation of motion is created by short “jolts” in the proper axis plus a corresponding change of view out the flight deck windows. The illusion of the ascent environment is further enhanced by simulated booster and main engine sounds along with induced vibration of the crew compartment. For lift–off simulation, once the students are strapped in their seats, the MB platform is tilted to a vertical position, thus placing the crewmembers on their backs as they would be in the real vehicle. The ensuing change of the MB to the horizontal position occurs very slowly, which helps create the illusion of the transition from a gravity environment to a zero–g environment.

The SMS Fixed Base (SMS–FB) and Guidance and Navigation Simulator (GNS) are two separate and independently operated and controlled complexes that are good replicas of the flight deck and aft flight deck. Figure 6–4 shows the SMS–FB. The flight deck and middeck areas cannot be seen because of all the supporting structures. Each middeck area consists of life–size photographs of real vehicle middeck components, flightlike power and communications outlets, and wooden lockers built to exact size to house the myriad of locker trays that contain orbiter flightcrew support equipment and payload experiments. Figure 6–5 shows the area used to support training that would typically take place in the orbiter middeck area. The very “roomy” area allows the crew to set up, assemble, and operate many experiments simultaneously.

The GNS was originally a partial replica of the flight deck and aft flight deck area and was used primarily for development and checkout of software loads that were to be used for training in the SMS–FB and SMS–MB. The GNS was later expanded to be a duplicate of the SMS–FB to be used as a second nonmotion facility for training; however, the GNS moniker “stuck.”

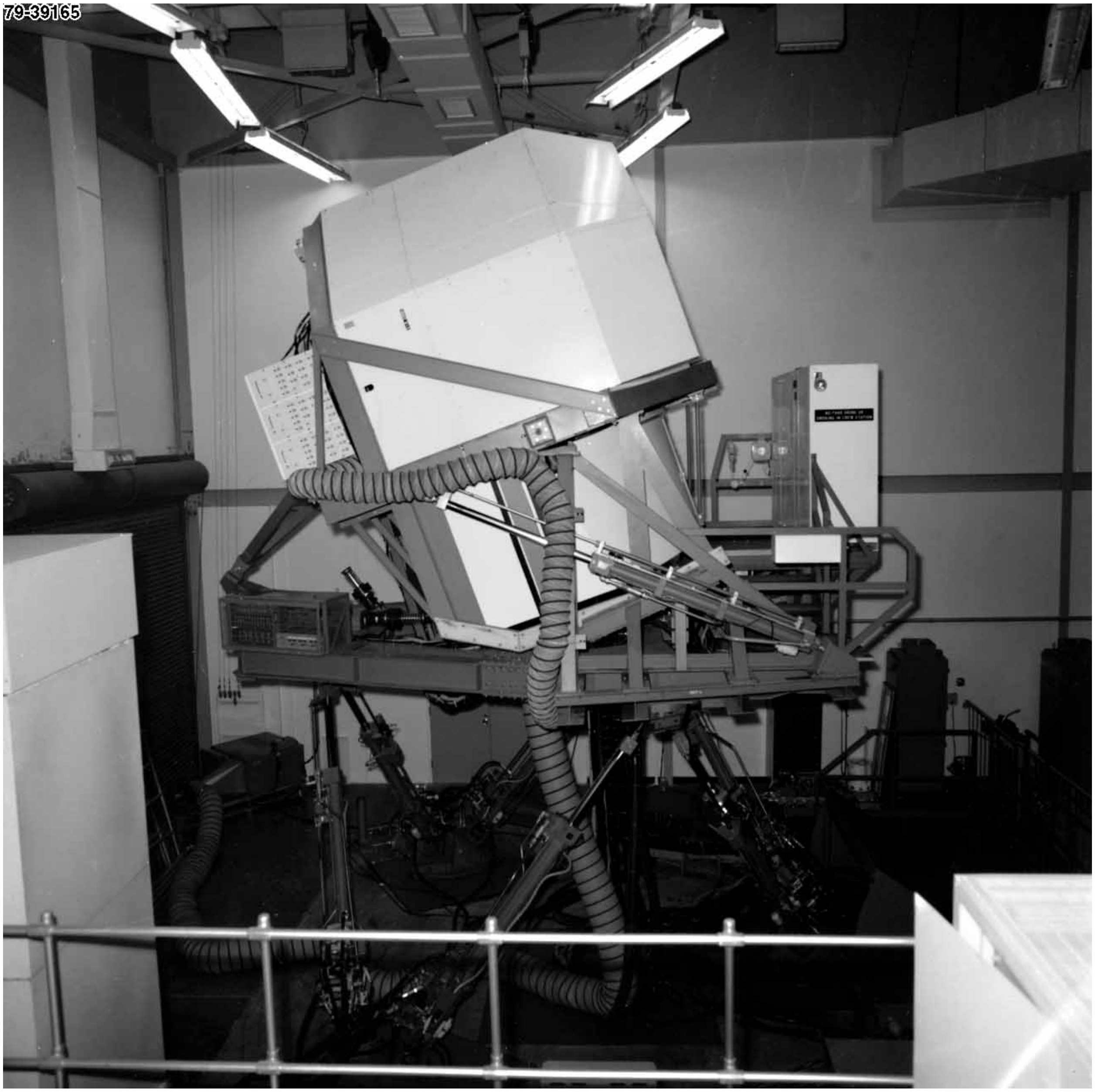

Figure 6–3. SMS motion base

Figure 6–4. SMS fixed base

Figure 6–5. SMS–SLS

Mockup and Integration Laboratory

The Mockup and Integration Laboratory (MAIL) is a large facility located in the high–ceiling northern portion of building 9 and consists of a numerous variety of individually controlled and operated development and/or training facilities. This section describes only the major facilities within this huge area. Figure 6–6 shows an overview of the MAIL and other training facilities in the building 9 high–bay area.

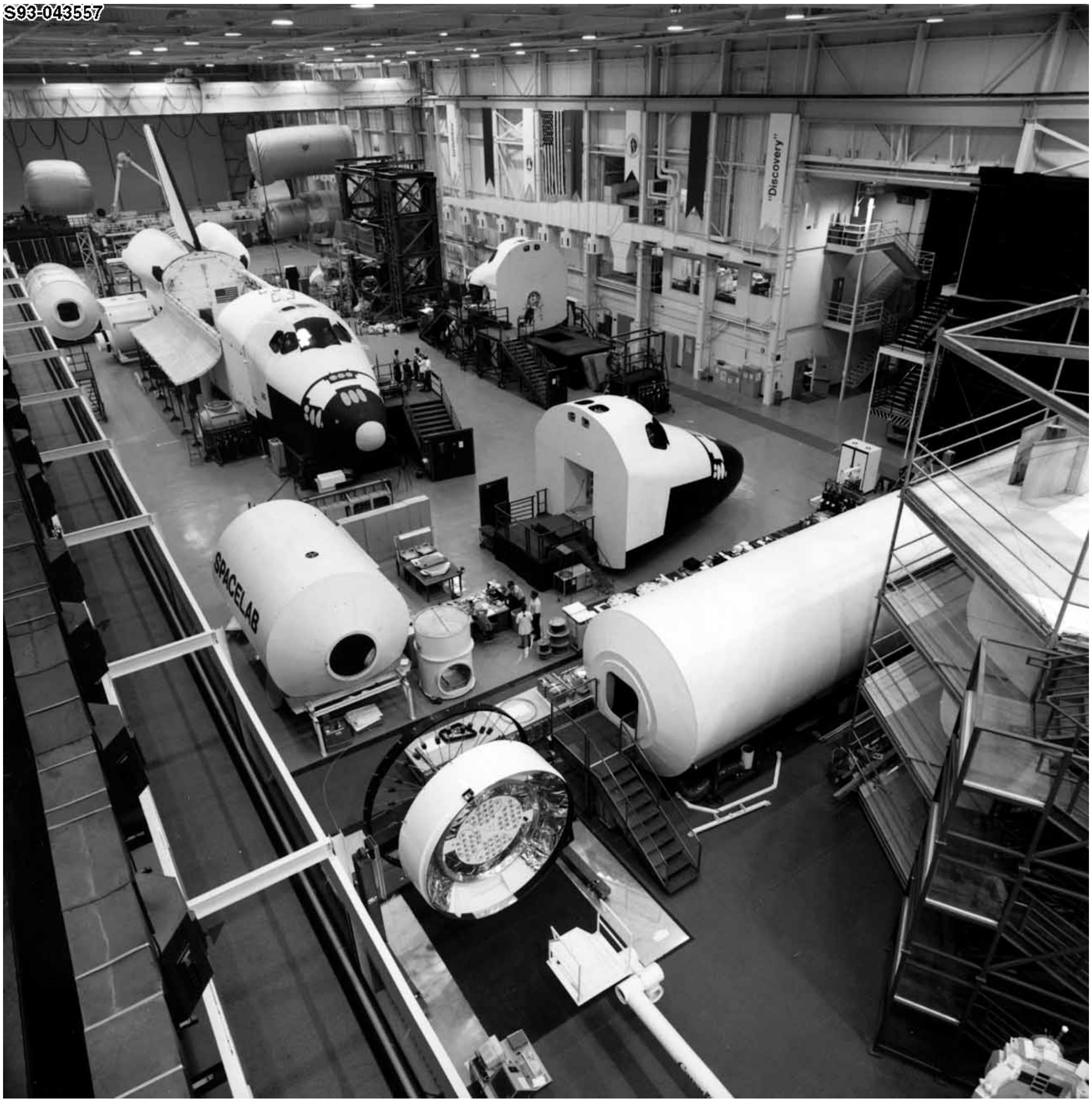

Figure 6–6. Building 9 overview

Crew Compartment Trainer

The Crew Compartment Trainer (CCT) facility is a very accurate physical replica of the crew compartment flight deck, aft flight deck, middeck, and airlock area. All dimensions are as true to the real vehicle as possible. Control panels, power outlets, hatches, windows, stowage lockers, flight seats, crew escape system, and other replicas are very flightlike in appearance and dimension. Both direct and alternating current are provided to enable developers and experimenters to plug in and operate their respective test articles and/or training hardware. Although all orbiter switches are physically operable, most of them are just dummy switches. Some switches, such as power on/off switches and those that control the crew galley mockup, are functional. Another system that is functional is the closed–circuit television (CCTV) system, which also allows operation of camcorders that are used on orbit for a variety of purposes.

The facility support personnel also provide a very thorough and complete complement of onboard crew equipment that can be stowed in the various lockers and other compartment locations as required by the flight manifest stowage plan. This equipment includes a host of articles that may be used by a flightcrew while on orbit; for example, in–flight maintenance tools, window shades and covers, still and motion picture photography cameras, camcorders, FDF, sleeping bags, power extension cables, and even EVA suits.

The objective of the CCT is to provide highly accurate engineering development, procedures development, or operations training for flightcrews, flight control, and instructor personnel in a high–fidelity orbiter crew compartment environment utilizing flightlike onboard crew support equipment. Development engineers can verify the compatibility of their hardware with other crew compartment equipment and perform preliminary fit checks. Flight procedure personnel can verify the procedures for their respective crew support equipment or payload experiment. Flightcrews can practice unstowing, setup, operational, disassembly, and stowing procedures for crew support equipment and experiments. Figure 6–7 shows the CCT in the horizontal position with the orbiter side hatch opening onto a movable staircase.

The CCT can also be configured in the vertical (launch mode) position to enable fully suited crews to practice ingress and egress procedures. Figure 6–8 shows the CCT in the vertical position with orbiter side hatch securely closed.

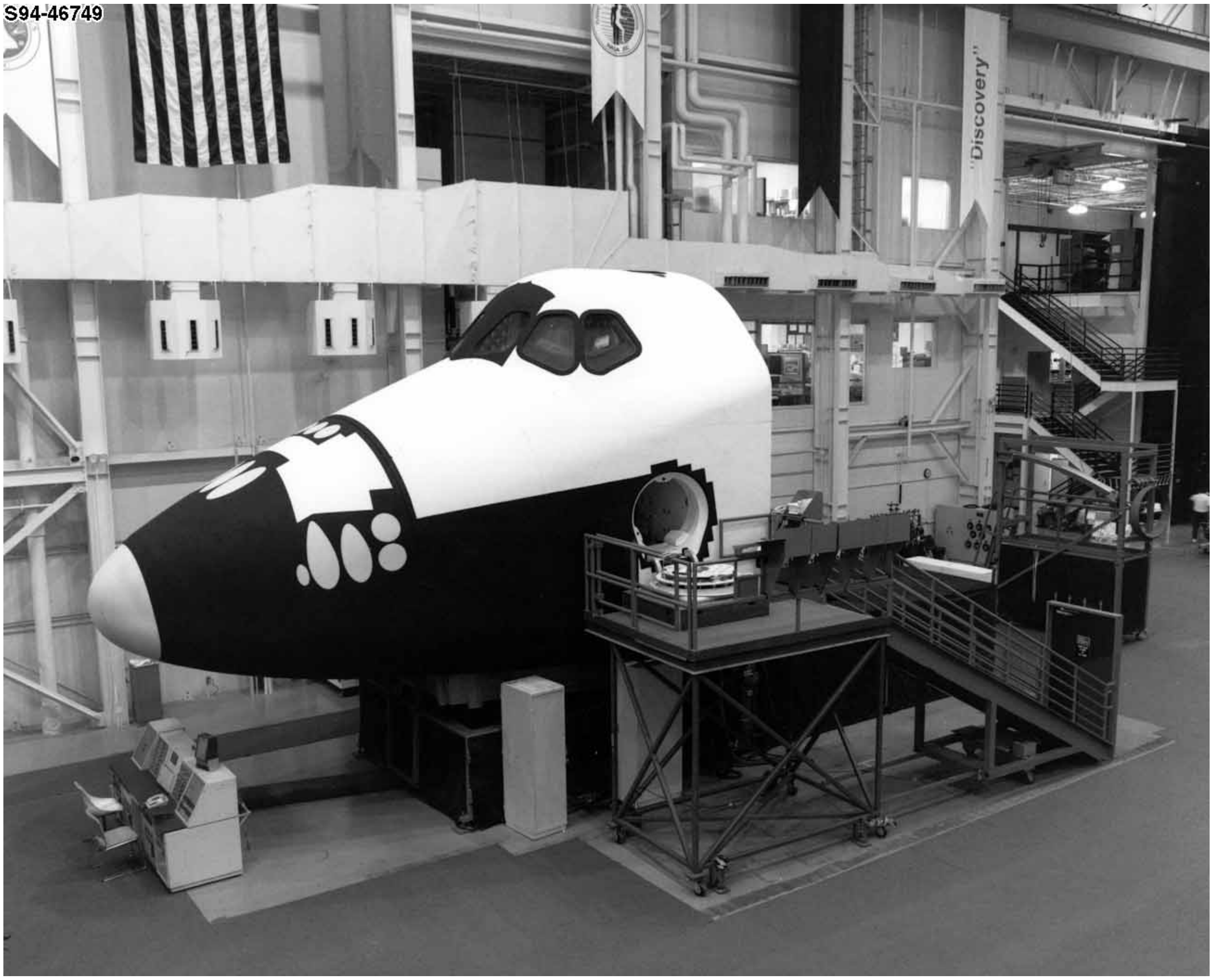

Figure 6–7. CCT in horizontal position

Figure 6–8. CCT in vertical position

Full Fuselage Trainer

This facility is a full–size physical replica of both the crew compartment and the payload bay. The capabilities, amenities, and support of the Full Fuselage Trainer (FFT) crew compartment are very similar to those available for the CCT crew compartment. Figure 6–9 shows the FFT.

The FFT also provides payload bay cameras that are interfaced with and operated by the crew compartment CCTV system. Life–size mockups of various payload bay elements, such as a Spacelab or Spacehab module, plus other customer–furnished life–size payload mockups can be hoisted and lowered into the FFT payload bay in their respective flight positions for whatever development or training may be required.

In addition to most of the capabilities offered by the CCT, the FFT can be used to train fully suited flightcrews on emergency egress procedures. Crewmembers can exit from the crew compartment top windows and rappel down to the floor.

Figure 6–9. FFT

Manipulator Development Facility

The MDF is another facility located in the high–ceiling eastern side of building 9 and consists of a full–size mockup of the payload bay, to which is attached a one–g operational replica of the RMS, or robot arm. Because this arm operates in the Earth's gravity environment, it was manufactured with sufficient strength to handle several hundred pounds of a payload mockup cantilevered at the end of the fully extended length of the arm.

This facility is an accurate physical replica of the payload bay. The RMS replica does not resemble the real arm in girth or construction since the real arm was designed and built only to maneuver objects in a zero–g environment and, therefore, does not require such strength for "lifting" objects. The total length of the arm and the lengths of the arm components are similar to the real vehicle. The operational characteristics and "feel" of the arm are very realistic, which is what makes the MDF a useful development and training tool.

A mockup of the aft flight deck with flightlike RMS monitor and control panels and a flightlike CCTV system is located forward of the payload bay, just as in the real vehicle. An RMS procedures developer or crewmember in training can operate the arm just as he or she would in the real vehicle. Helium–filled balloons or lightweight mockups that simulate a variety of payloads can be "retrieved," maneuvered, and installed into a flightlike mounting bracket in the payload, or, vice versa, can be "deployed" from a mounting bracket in the payload bay. In both situations, the arm operator must visually maneuver the arm to the mockup's RMS attachment fixture, secure the article, and then maneuver it to the intended new location.

Figure 6–10 shows the MDF with the RMS grappling a helium–filled balloon.

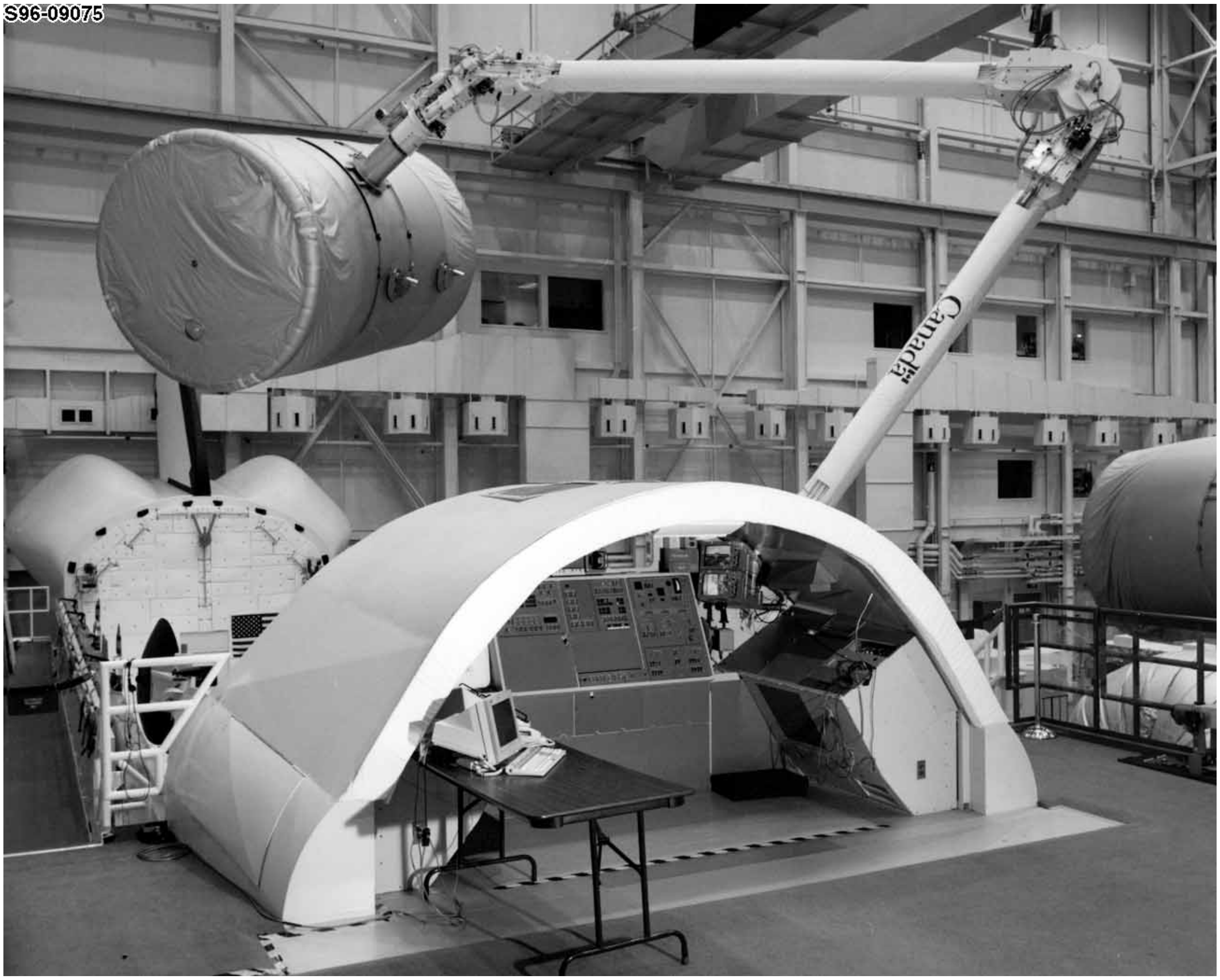

Figure 6–10. MDF demonstrating a loaded arm

Neutral Buoyancy Laboratory

The NBL is another training facility located in the cavernous open area of building 29, the circular building that once housed a centrifuge. The NBL is a complex that encloses a large 202–foot–long, 102–foot–wide, 40–foot–deep pool of water in which a full–size mockup of the payload bay is totally submerged. Full–size structural mockups of payloads or other payload articles can be submersed and installed into the NBL payload bay.

The objective of the NBL is to provide, as realistically as possible, hands–on training for the EVA tasks that the flightcrew either must perform as part of their mission or may be required to perform in the event of a failure requiring EVA to remedy. A crewmember training for EVA activities dons a spacesuit and then is lowered and submersed in the water. The suit is weighted in such a way that the crewmember neither floats nor sinks and, therefore, is free to move about the payload bay in a manner very similar to that which is experienced in the zero–g environment. Divers stand by to assist the crewmember in the event of an emergency.

Cameras are installed underwater in positions that duplicate their respective positions in the real vehicle. This visual information is routed to an area where instructors and other interested persons may monitor crewmember progress and performance. Microphones and headsets are placed within the spacesuit helmet to allow two–way conversation between the crewmember and the instructor staff or among the crewmembers. The NBL can also be integrated with the SMS in support of integrated or joint–integrated simulations.

Figure 6–11 shows the NBL configured to support an EVA training exercise with crewmembers and divers preparing to enter the water. Figure 6–12 is an underwater view of a typical training exercise.

Shuttle Engineering Simulator

The Shuttle Engineering Simulator (SES) is a training facility located in building 16. The SES contains mockups of the crew compartment aft and forward flight decks and simulated visuals of the payload bay, RMS, and various payloads. The primary objective of the SES is to develop shuttle and payload operational procedures and, secondly, to train flightcrew members, instructors, and operations personnel. These development and training efforts are primarily directed to RMS, rendezvous, and proximity procedures and operations. Visual depictions of payloads and the RMS are realistic, and the characteristics of the RMS as well as payload dynamics are very accurately simulated.

Figure 6–11. NBL preparation

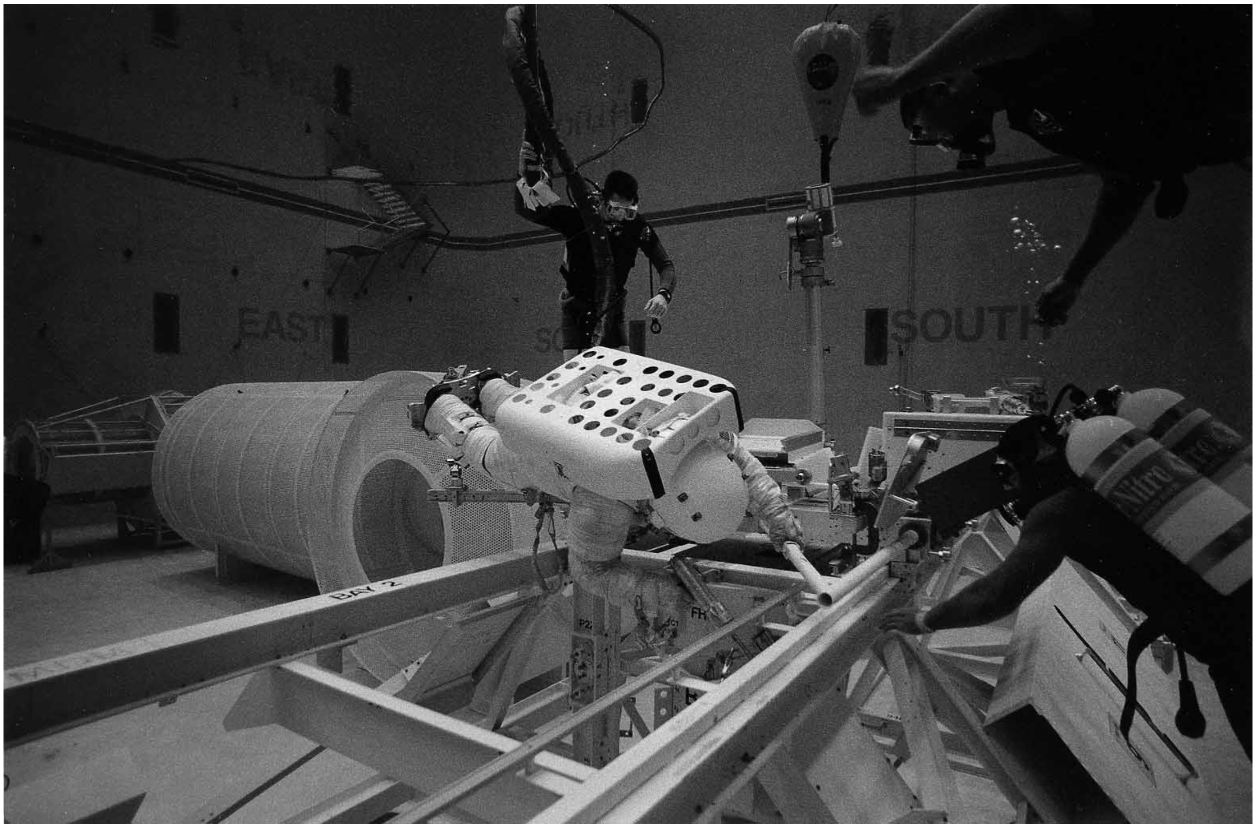

Figure 6–12. NBL underwater training

Appendix A
Acronyms and Abbreviations

ASL	Application Specific Language
C&D	Control and Display
CCT	Crew Compartment Trainer
CCTV	Closed–Circuit Television
CIR	Cargo Integration Review
CRT	Cathode–Ray Tube
CSR	Customer Support Room
DACUM	Design A Curriculum
DPS	Data Processing System
DR	Discrepancy Report
DVIS	Digital Voice Interfacing System
E&MD	Engineering and Maintenance Division
EVA	Extravehicular Activities
FB	Fixed Base
FBCS	Fixed Base Crew Station
FCR	Flight Control Room
FDA	Fault Detection Annunciation
FDF	Flight Data File
FFT	Full Fuselage Trainer
FOIG	Flight Operations Integration Group
FOR	Flight Operations Review
FOSA	Flight Operations Support Annex
FOSP	Flight Operations Support Personnel
FRR	Flight Readiness Review
G&C	Guidance and Control
GNC	Guidance, Navigation, and Control
GNS	Guidance and Navigation Simulator
GPC	General Purpose Computer
GPM	General Payload Model
GSFC	Goddard Space Flight Center
GSTDN	Ground Space Flight Tracking and Data Network
JIS	Joint Integrated Simulation
JISWG	Joint Integrated Simulation Working Group
JOH	Joint Integrated Simulation Operations Handbook
JOIP	Joint Operations Interface Procedures
JSC	Lyndon B. Johnson Space Center
KSC	John F. Kennedy Space Center
L	Launch

MAIL	Mockup and Integration Laboratory
MB	Motion Base
MCC	Mission Control Center
MCC–H	Mission Control Center–Houston
MDF	Manipulator Development Facility
MDM	Multiplexer/Demultiplexer
MET	Mission Elapsed Time
MOD	Mission Operations Directorate
MPSR	Multipurpose Support Room
MSFC	Marshall Space Flight Center
MSID	Measurement Stimulation Identification
NASA	National Aeronautics and Space Administration
NBL	Neutral Buoyancy Laboratory
NSS	Network Simulation System
P/L	Payload
PAM	Payload Assist Module
PCTC	Payload Crew Training Complex
PDI	Payload Data Interleaver
PIP	Payload Integration Plan
POCC	Payload Operations Control Center
POWG	Payload Operations Working Group
PPS	Payload Prelaunch Simulation
PTS	Payload Training Supervisor
RMS	Remote Manipulator System
SCA	Simulation Control Area
SES	Shuttle Engineering Simulator
SFT&FO	Spaceflight Training and Facility Operations
sim	Simulation
Sim Sup	Simulation Supervisor
SLS	Spacelab Simulator
SMS	Shuttle Mission Simulator
SMS–FB	SMS–Fixed Base
SMS–MB	SMS–Motion Base
SSP	Space Shuttle Program
SST	Single System Trainer
STDN	Spaceflight Tracking and Data Network
TCDT	Terminal Countdown Demonstration Test
TDRSS	Tracking and Data Relay Satellite System

Appendix B
Customer Familiarization Briefing Guidelines

The objective of the Payload Familiarization (FAM) briefing is to educate your audience of astronauts, MCC controllers, payload mission management, payload operators, and instructors from the MOD Training Division about your flight–specific payload. Your audience is most interested in how they interact with your payload and how their areas of expertise can best be utilized to ensure the safe and successful operation of your payload.

The briefing should be customized to meet the level of detail required for your audience. For example, if the briefing is the first of many planned training sessions, it should provide only introductory top–level material to develop the foundation for future training. If the briefing is the only planned training session, which is typical for secondary and middeck payloads, then the briefing should provide more in–depth details on the systems and operational aspects of your payload. Another option is to defer the detailed scientific, engineering, and programmatic aspects of your payload to a separate training exercise that may be required only for specific personnel, such as the flight crew. We encourage you to include a demonstration or exhibit of your payload using flight, flight–similar, or mockup hardware.

We recommend that the person or persons presenting the FAM briefing should have, as a minimum, the ability to field questions and address issues pertaining to the science of the payload and payload operations, including interfaces with the shuttle and the shuttle environment. The time allocation for the FAM briefing for most secondary and middeck type payloads should be about an hour. Depending on the complexity of the payload and the number of questions, more time can be scheduled. Your FAM briefing will be videotaped for future review training.

For additional information, including a suggested outline format and generic topics that should be addressed during the payload FAM briefing, refer to the Payload Familiarization Briefing Guidelines document, JSC–25716.

Appendix C
Standard Joint Integrated Simulation Working Group Agendas

To provide consistency among different Payload Training Supervisors dealing with the customers, the following is proposed as a standard agenda with detailed products that result from the JISWGs. This may vary with the complexity of the payload and its interfaces with the shuttle. However, the goal or plan is to baseline three or fewer JISWGs per major payload. To accomplish this, the PTS must accomplish the following tasks:

- JISWGs are arranged and conducted by the PTS. The PTS announces the agenda, time, and place of JISWG by memo in coordination with the customer.
- The PTS is at least the cochairperson of the JISWG, leads discussions, follows the agenda, and assigns a notetaker to take the minutes of the meeting and to assign and track action items.
- The first JISWG meeting should be scheduled shortly after the first POWG meeting, but is generally not required until after L – 18 months.
- Subsequent JISWGs should be scheduled as required to fulfill objectives of the agenda.

JISWG No. 1 Agenda

1. Introduction

   Purpose – PIP and annexes relationships
   Developing JOH, if required

2. Detailed responsibilities

   Organizations
   POWG/JISWG/FOIG relationship

3. Flight controller and crew tasks

   Displays and payload operation task (MCC–H, orbiter)
   Data flow – Interfaces

4. Training objectives

   Mission training objectives
   Particular JIS training objectives and number of JISs needed
   Voice comm protocol sims, if required

5. Simulator configuration

6. Scheduling

   Script cycle
   Future JISWGs

7. JISWG no. 2 requirements
8. Action item review

JISWG No. 2 Agenda

1. Introduction
2. Review JIS training objectives
3. Generate major malfunctions
4. Preliminary review of the JOH, if required
5. JISWG no. 3 requirements
6. New action item review

JISWG No. 3 Agenda

1. Review old action items
2. Review script inputs
3. Review major malfunctions
4. Review final JOH, if required
5. Close out all action items

List of Products From JISWG No. 1

1. Malfunction timelines
2. Update of JOH, if required
3. Update of training objectives
4. Minutes of meeting

List of Products From JISWG No. 2/3

1. Malfunction timelines
2. Major script inputs
3. Final JOH marked up, if required
4. Minutes of meeting

Appendix D
People to Contact

Listed below are several customer concerns and a point of contact for each.

Point of contact	Phone number	Mail code
Payload Operations	244–0247	DO6
Space Flight Training Division	244–7518	DT
Systems Training Branch	244–7444	DT4
Spaceflight Training and Facility Operations	244–7564	DT3
Station Data, Dynamics, and Planning Group	244–7387	DT22
Station Training Leads	244–7116	DT6
Avionics Training Branch	244–7361	DT2
Joint Integrated Sim Scheduling: • Payload Officer, Payload and Ops Support Branch	244–0247	DO6
Payload Specialist Scheduling: • Training Manager, Training Division	244–7529	DT32
Scripting Information: • Sim Supervisor, Training Division	244–7693	DT32
Simulation Support: • Payload Training Supervisor	244–7574	DT37
PIP Section 8.3 and the PIP Training Annex: • Training Annex Manager	244–7566	DT37
Scheduling Information: • Schedules and Flow Management Office	244–7692	DT32

Training Materials Evaluation

Please answer the following questions regarding the lesson you just completed. Your feedback will allow us to produce more effective training materials. When complete, mail to: **Cargo Systems Group, DT37.**

TITLE/CODE OF LESSON: JSC Training Guide for SSP Customers

SIZE OF AUDIENCES/CLASS: __________

1. How well did this lesson meet its purpose?

For each statement below, mark one box on the scale:

	Strongly Disagree				Strongly Agree
a. The lesson objectives are clearly stated.	☐	☐	☐	☐	☐
b. The lesson objectives are clearly defined.	☐	☐	☐	☐	☐
c. The lesson effectively teaches skills and information.	☐	☐	☐	☐	☐
d. The lesson meets its purpose and objectives.	☐	☐	☐	☐	☐

2. How satisfying is the content of this lesson?

For each statement below, mark one box on the scale:

	Strongly Disagree				Strongly Agree
a. The information is structured in a logical flow.	☐	☐	☐	☐	☐
b. The content is clear.	☐	☐	☐	☐	☐
c. The content is complete.	☐	☐	☐	☐	☐
d. The level of detail is correct for this information.	☐	☐	☐	☐	☐
e. The amount of information is effective.	☐	☐	☐	☐	☐
f. The graphics contribute to my understanding.	☐	☐	☐	☐	☐

3. How appealing was the presentation of this lesson?

For each statement below, mark one box on the scale:

	Strongly Disagree				Strongly Agree
a. The overall presentation is appealing.	☐	☐	☐	☐	☐
b. The visuals chosen are appropriate for the lesson.	☐	☐	☐	☐	☐
c. The visuals make the information more interesting.	☐	☐	☐	☐	☐
d. The graphics are legibly reproduced.	☐	☐	☐	☐	☐
e. The audio/visual or print quality is good.	☐	☐	☐	☐	☐

4. How valuable is this information?

For each statement below, mark one box on the scale:

	Strongly Disagree				Strongly Agree
a. The lesson teaches skills and information I need.	☐	☐	☐	☐	☐
b. The lesson meets my expectations.	☐	☐	☐	☐	☐
c. This information is useful for later reference.	☐	☐	☐	☐	☐
d. I would recommend this lesson to others.	☐	☐	☐	☐	☐

PLEASE WRITE YOUR COMMENTS/QUESTIONS ON THE BACK OF THIS FORM.
EXPLAIN ANY NEGATIVE ANSWERS IN SPECIFIC TERMS
THANK YOU IN ADVANCE FOR YOUR ASSISTANCE!